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RESEARCH MEMORANDUM

SCALING THE PROPOSED NEW ARMED FORCES QUALIFICATION TEST COMPOSED OF VERBAL, ARITHMETIC REASONING, AND MATH KNOWLEDGE

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The Numerical Operations (NO) subtest has caused problems for the joint-service testing program since it was made part of the Armed Forces Qualification Test (AFQT) in 1980. A new AFQT, in which the Math Knowledge (MK) subtest replaces NO, was recommended by the Joint Service Selection and Classification Working Group in 1986. The purpose of this research memorandum is to present percentile score norms for the proposed new AFQT in the 1980 Youth Population and the scaling of the current forms of the AFQT to the 1980 score scale.

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1. Enclosure (1) is forwarded as a matter of possible interest.

2. An important part of the Armed Services Vocational Aptitude Battery (ASVAB) is the Armed Forces Qualification Test (AFQT). A new AFQT has been proposed in which the Math Knowledge subtest replaces the Numerical Operations subtest. The purpose of this Research Memorandum is to present percentile score norms for the proposed new AFQT in the 1980 Youth Population and the scaling of the new AFQT in ASVAB forms 11, 12, and 13 to the 1980 score scale.

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ABSTRACT

The Numerical Operations (NO) subtest has caused problems for the joint-service testing program since it was made part of the Armed Forces Qualification Test (AFQT) in 1980. A new AFQT, in which the Math Knowledge (MK) subtest replaces NO, was recommended by the Joint Service Selection and Classification Working Group in 1986. The purpose of this research memorandum is to present percentile score norms for the proposed new AFQT in the 1980 Youth Population and the scaling of the current forms of the AFQT to the 1980 score scale.

EXECUTIVE SUMMARY

BACKGROUND

The Numerical Operations (NO) subtest was made part of the Armed Forces Qualification Test (AFQT) in October 1980 when forms 8, 9, and 10 of the Armed Services Vocational Aptitude Battery (ASVAB 8/9/10) were introduced. The AFQT contained the Word Knowledge (WK), Paragraph Comprehension (PC), and Arithmetic Reasoning (AR) subtests, in addition to NO (AFQT = WK + PC + AR + NO/2[1]). Since 1980, the NO scores, and resultant AFQT scores, have been found to be affected by the design of test booklets and answer sheets. A more serious problem is that examinees can prepare for the NO test and thereby increase their NO scores. Most of the increase occurs at the lower range of ability.

The Joint Service Selection and Classification Working Group, which is responsible for the development and maintenance of the ASVAB, recommended in 1986 that the NO subtest be dropped from the AFQT and replaced by the Math Knowledge (MK) subtest. The new AFQT would then be defined as: AFQT = WK + PC + AR + MK.

The purpose of this report is to present percentile-score norms for the proposed new AFQT in the 1980 Youth Population and the scaling of the new AFQT in current forms of the ASVAB (forms 11, 12, and 13) to the 1980 score scale. Keywords: aptitude tests; skills; human performance; personnel selection

PROCEDURE

The data set used for constructing the percentile norms in the 1980 Youth Population consisted of scores from an administration of ASVAB 8A to a nationally representative sample of males and females aged 18 through 23 at the time of testing (called the 1980 Youth Population). The scaling of the new AFQT in ASVAB 11/12/13 to the 1980 Youth Population was accomplished using a set of ASVAB scores from applicants tested in October and November of 1984 during the Initial Operational Test and Evaluation (IOT&E) of ASVAB 11/12/13. Both equipercentile and linear equating gave very similar results; consequently the linear equating results were selected.

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1. The NO score is divided by two and summed with the other subtest raw scores (number of items correct). The sums of raw scores are converted to percentile scores, and the percentile scores are used in making personnel decisions.

For maximum precision a large number of significant digits were retained at all intermediate stages of the equating. Only at the final step were results rounded to produce integer percentiles.

RESULTS

- *Percentile Score Norms for the New AFQT in the 1980 Youth Population.* The conversion of raw scores[1] of the new AFQT to percentile scores in the 1980 Youth Population is shown in table I. The relationship is smooth and orderly, as is desirable for a set of norms. These norms are appropriate for use with ASVAB 8, 9, and 10, which are parallel to ASVAB 8A, and ASVAB 14, which is used in the Institutional Testing Program.

- *Scaling of the New AFQT for ASVAB 11/12/13 to the 1980 Youth Population.* Two new AFQT conversion tables were constructed: One is for forms 11A, 11B, 12B, 13A, 13B, which are sufficiently similar to each other that a common table can be used for all of them. The second conversion table is for form 12A, which has slightly more difficult items and therefore warranted a separate table. The conversion of new AFQT raw scores to percentile scores for forms 11A, 11B, 12B, 13A, and 13B is shown in table II, and that for form 12A in table III.

RECOMMENDATIONS

- The norms contained in this report should be be used when the new AFQT is implemented.

- For maximum precision subsequent forms of ASVAB should be scaled to the 1980 Youth Population using the six-digit cumulative frequency tables presented in this report.

1. The AFQT is currently defined as a sum of subtest raw scores. There has been some discussion of the desirability of defining it as a sum of subtest standard scores.

TABLE I

CONVERSION OF NEW AFQT RAW SCORES TO PERCENTILE SCORES IN THE 1980 YOUTH POPULATION FOR ASVAB FORM 8A

Raw score	Percentile score	Raw score	Percentile score
1	0	41	14
2	0	42	15
3	0	43	16
4	0	44	17
5	0	45	18
6	0	46	19
7	0	47	20
8	0	48	21
9	0	49	22
10	0	50	23
11	0	51	24
12	0	52	25
13	0	53	26
14	0	54	27
15	0	55	28
16	0	56	30
17	0	57	31
18	1	58	32
19	1	59	34
20	1	60	35
21	1	61	36
22	2	62	37
23	2	63	39
24	2	64	40
25	3	65	42
26	3	66	43
27	4	67	45
28	4	68	46
29	5	69	48
30	6	70	49
31	6	71	50
32	7	72	52
33	8	73	53
34	8	74	55
35	9	75	56
36	10	76	58
37	11	77	60
38	12	78	61
39	12	79	63
40	13	80	65

TABLE I (Cont.)

Raw score	Percentile score
81	66
82	68
83	69
84	71
85	72
86	74
87	75
88	77
89	78
90	80
91	81
92	82
93	84
94	86
95	87
96	89
97	90
98	92
99	93
100	95
101	96
102	98
103	99
104	99
105	99

TABLE II

CONVERSION OF NEW AFQT RAW SCORES TO PERCENTILE SCORES FOR FORMS 11/12B/13

Raw score	Percentile score	Raw score	Percentile score
1	0	41	17
2	0	42	17
3	0	43	18
4	0	44	19
5	0	45	20
6	0	46	21
7	0	47	22
8	0	48	23
9	0	49	24
10	0	50	25
11	0	51	26
12	1	52	27
13	1	53	28
14	1	54	30
15	1	55	31
16	1	56	32
17	2	57	33
18	2	58	34
19	2	59	35
20	3	60	36
21	3	61	38
22	4	62	39
23	4	63	40
24	5	64	42
25	5	65	43
26	6	66	44
27	6	67	45
28	7	68	47
29	8	69	48
30	8	70	50
31	9	71	51
32	10	72	52
33	10	73	53
34	11	74	55
35	12	75	56
36	13	76	57
37	13	77	59
38	14	78	61
39	15	79	62
40	16	80	64

TABLE II (Cont.)

Raw score	Percentile score
81	65
82	67
83	68
84	69
85	71
86	72
87	73
88	75
89	76
90	78
91	79
92	80
93	81
94	83
95	84
96	86
97	87
98	89
99	90
100	91
101	93
102	94
103	96
104	97
105	98

TABLE III

CONVERSION OF NEW AFQT RAW SCORES TO PERCENTILE SCORES FOR FORM 12A

Raw score	Percentile score	Raw score	Percentile score
1	0	41	18
2	0	42	19
3	0	43	20
4	0	44	21
5	0	45	22
6	0	46	23
7	0	47	23
8	0	48	24
9	0	49	26
10	0	50	27
11	1	51	27
12	1	52	29
13	1	53	30
14	1	54	31
15	1	55	32
16	2	56	33
17	2	57	34
18	3	58	36
19	3	59	37
20	4	60	38
21	4	61	39
22	5	62	41
23	5	63	42
24	6	64	43
25	6	65	44
26	7	66	46
27	8	67	47
28	8	68	49
29	9	69	50
30	9	70	51
31	10	71	52
32	11	72	54
33	12	73	55
34	12	74	56
35	13	75	58
36	14	76	59
37	15	77	61
38	15	78	62
39	16	79	64
40	17	80	65

TABLE III (Cont.)

Raw score	Percentile score
81	67
82	68
83	69
84	71
85	72
86	73
87	75
88	76
89	78
90	79
91	80
92	81
93	82
94	84
95	85
96	87
97	88
98	90
99	91
100	92
101	93
102	95
103	96
104	98
105	99

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INTRODUCTION

The Armed Forces Qualification Test (AFQT) is the primary score obtained from the Armed Services Vocational Aptitude Battery (ASVAB). The AFQT is used by all services as the first screen to determine qualification for enlistment and for historical tracking of the aptitudes of recruits. Because of its importance in evaluating applicants for enlistment, both recruiters and applicants have a strong interest in the level of AFQT scores. Coaching on the ASVAB tends to be focused on the subtests that comprise the AFQT.

In October 1980, the Numerical Operations (NO) subtest was added to the AFQT for the purpose of reducing cheating. NO is a speeded test, consisting of 50 items that involve addition, subtraction, multiplication, and division of one- or two-digit numbers; the test has a 3-minute time limit. In 1980, no one suspected the pitfalls of using a speeded test in an operational testing program in which the same types of items are administered daily to people applying for employment.

Since 1980, the ASVAB testing program has been plagued with problems stemming from the NO subtest. As a result, the Joint Service Selection and Classification Working Group, which has responsibility for the development and maintenance of the ASVAB and other testing procedures, recommended in 1986 that the NO subtest be replaced in the AFQT by the Math Knowledge subtest [1].

Problems with the NO subtest have been found to arise from subtle changes in the format of the items and the type font [1] and from the size and shape of response spaces on answer sheets [2]. More recently [3], inherent defects in NO arising from its use in an operational testing program were documented; examinees can learn test-taking strategies that inflate their test scores but not their underlying ability to work fast and accurately in the work environment.

In addition to problems with maintaining the accuracy of the test scores, NO is a poor measure of general trainability [4], which the AFQT is intended to measure. NO has little unique predictive validity for occupational specialty training courses, and its usefulness tends to be restricted to specialties in the clerical field. The limited usefulness of NO as a predictor of performance, coupled with its inherent defects in an operational testing program, render it inappropriate for the AFQT. The AFQT proposed by the Working Group, in which the Math Knowledge (MK) subtest replaces NO, is superior as a measure of general trainability and in the accuracy of its scores.

The primary purpose of this report is to present the results of norming the new AFQT, defined as Verbal (VE), which is the sum of Word Knowledge (WK) and Paragraph Comprehension (PC), Arithmetic Reasoning (AR), and MK, in the 1980 Youth Population. The equating of the new AFQT on forms 11, 12, and 13 of the ASVAB (ASVAB 11/12/13), introduced on 1 October 1984, to form 8A of the ASVAB (ASVAB 8A) administered to the 1980 Youth Population is also presented. The 1980 Youth Population serves as the reference for the ASVAB score scale.

CONSTRUCTING THE AFQT SCORE SCALE

Procedures

AFQT scores are reported on a percentile score scale. In the Department of Defense testing program, percentile scores are defined as the proportions of the population that score at or below each raw score. Accordingly, the cumulative proportion of the 1980 Youth Population was computed for each new AFQT raw score (reported to six decimals) and then rounded to an integer, which is the percentile score corresponding to each raw score. No smoothing of the frequencies for the raw scores or cumulative proportions was performed. However, percentile scores corresponding to the bottom of the AFQT score categories (10, 16, 21, 31, 50, 65, and 93) was in one instance forced by moving down the next higher percentile score. The reason is that these percentile scores are widely used in classifying recruits, and personnel managers prefer to have percentile scores at these values.

The new AFQT on forms 11, 12, and 13 of the ASVAB (ASVAB 11/12/13) was equated to form 8A using applicants from the Initial Operational Test and Evaluation (IOT&E) for ASVAB 11/12/13 conducted in October and November 1984. These applicants are called the 1984 IOT&E group. In the 1984 IOT&E, form 8A was labeled 13C; form 8A is used as the reference for equating because it was administered to the 1980 Youth Population. Form 12A was equated separately from the other five forms (11A, 11B, 12B, 13A, and 13B). As is the practice for the current AFQT, which contains NO, the latter five forms were combined and a common conversion table used for the five forms. The norming of the new AFQT for each form (11A, 11B, 12A, 12B, 13A, 13B) is presented in appendix A.

The general procedure in equating the AFQT was first to compute the 8A raw score that is equivalent to each 11/12B/13 and 12A raw score. The range of raw scores is from 0 through 105. The cumulative proportion of the 1980 Youth Population that would have obtained each 8A raw score was computed using linear interpolation.

Equatings were accomplished using both the linear and equipercentile techniques. Details of the equating procedures are presented subsequently for each technique.

Norming the New AFQT in the 1980 Youth Population

The cumulative proportions of the new AFQT raw scores for the 1980 Youth Population are shown in table 1. The proportions are shown to six decimal places and as integers. No smoothing of the frequencies that attained each raw score or of the cumulative proportions was performed. The conversion of form 8A raw scores to percentile scores is plotted in figure 1. Several adjustments, however, were made in the final set of percentile scores:

- Following conventional practice for the ASVAB score scale, the percentile scores were truncated at 99.

- The raw score of 71 was converted to a percentile score of 50, vice 51. The percentile score of 50 is widely used in making classification decisions, and personnel managers prefer to have a percentile score of that value. The shift in converting a raw score of 71 to a percentile score of 50 does not change the percentage of examinees who score at or above the median.

- The raw score of 46 was converted to a percentile score of 19, vice 18. This change was made because two adjacent raw scores (45 and 46) would be converted to the percentile score of 18 if conventional rounding practice were followed.

The percentile scores in table 1 are to be used for forms 8, 9, 10 and 14 of the ASVAB. Form 14 is used in the Institutional Testing Program. Form 8A is the reference test used for scaling new forms of the ASVAB to the 1980 Youth Population. Form 9 is used for retesting inservice personnel and is called the Armed Forces Classification Test. The six-decimal cumulative proportions can be used for equating future forms of the new AFQT to 8A.

The cumulative proportions for males and females in the 1980 Youth Population are shown in table 2. These data can be used for comparing male and female applicants and accessions to the potential supply in the current population.

TABLE 1

CUMULATIVE PROPORTIONS OF THE NEW AFQT IN THE 1980 YOUTH POPULATION

Form 8A raw score	Cumulative proportion	Percentile score
1	.001052	0
2	.001094	0
3	.001130	0
4	.001169	0
5	.001169	0
6	.001232	0
7	.001413	0
8	.001605	0
9	.001649	0
10	.001649	0
11	.001887	0
12	.002105	0
13	.002105	0
14	.002733	0
15	.003012	0
16	.003447	0
17	.004469	0
18	.006112	1
19	.007858	1
20	.009953	1
21	.011860	1
22	.015521	2
23	.019517	2
24	.023467	2
25	.028836	3
26	.033691	3
27	.039062	4
28	.044980	4
29	.050616	5
30	.056731	6
31	.063638	6
32	.071615	7
33	.077546	8
34	.084758	8
35	.092910	9
36	.098927	10
37	.107460	11
38	.115154	12
39	.123816	12
40	.131901	13

TABLE 1 (Cont.)

Form 8A raw score	Cumulative proportion	Percentile score
41	.139978	14
42	.149002	15
43	.158462	16
44	.167213	17
45	.175550	18
46	.184738	19
47	.193733	20
48	.208275	21
49	.218680	22
50	.229271	23
51	.237897	24
52	.251203	25
53	.262209	26
54	.272117	27
55	.284599	28
56	.299895	30
57	.310825	31
58	.322577	32
59	.336511	34
60	.348383	35
61	.361121	36
62	.373615	37
63	.390123	39
64	.404774	40
65	.420093	42
66	.433347	43
67	.445852	45
68	.461027	46
69	.477508	48
70	.492189	49
71	.506667	50
72	.520164	52
73	.533398	53
74	.547743	55
75	.564460	56
76	.577183	58
77	.595509	60
78	.613826	61
79	.631347	63
80	.646158	65

TABLE 1 (Cont.)

Form 8A raw score	Cumulative proportion	Percentile score
81	.662882	66
82	.679012	68
83	.693621	69
84	.708045	71
85	.723670	72
86	.737715	74
87	.753028	75
88	.768328	77
89	.784039	78
90	.797256	80
91	.810570	81
92	.823073	82
93	.840731	84
94	.855878	86
95	.871364	87
96	.889685	89
97	.903954	90
98	.917760	92
99	.933403	93
100	.950002	95
101	.964157	96
102	.977846	98
103	.989889	99
104	.997310	99
105	1.000000	99

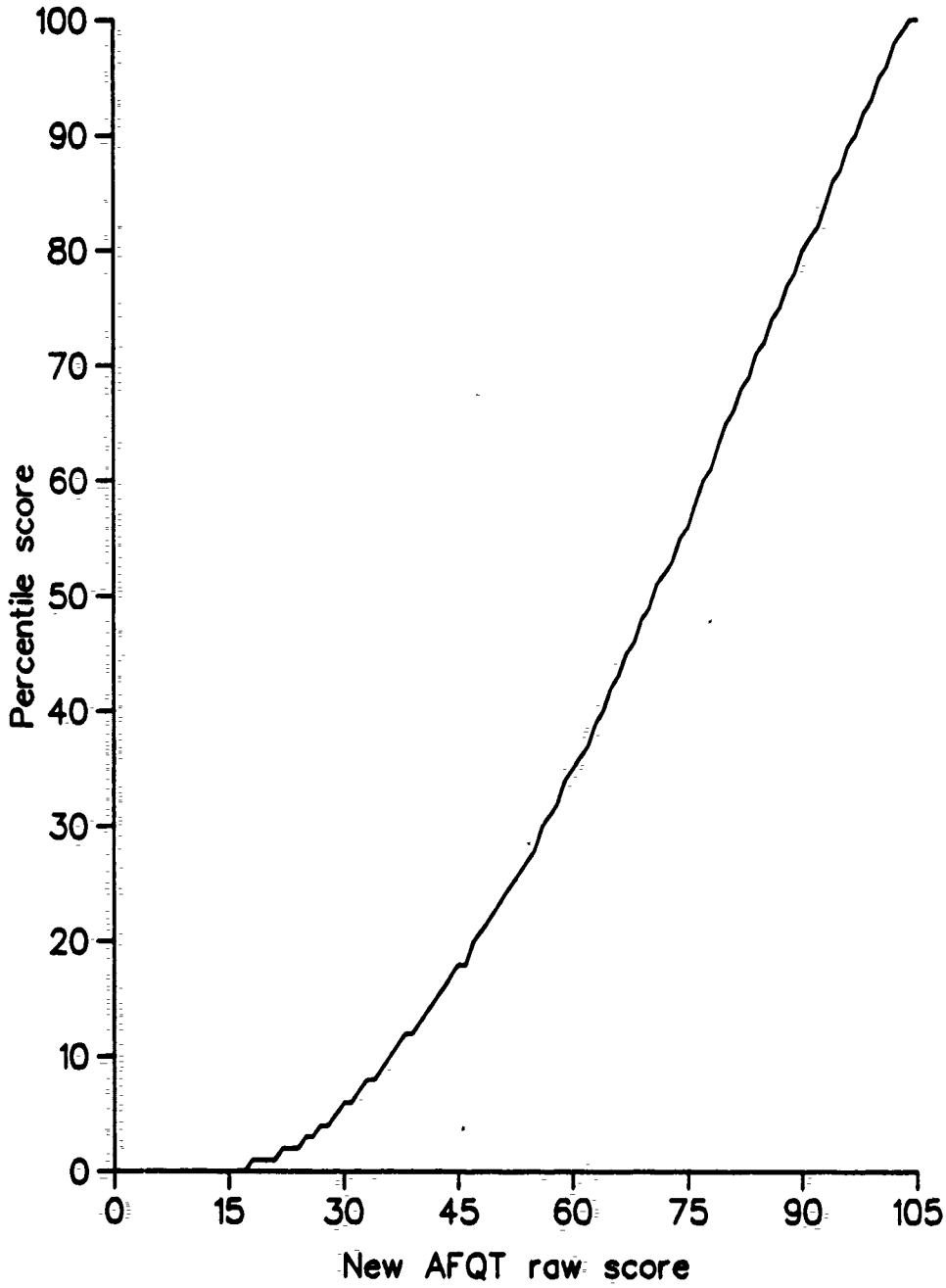

FIG. 1: CONVERSION OF NEW AFQT RAW SCORES TO PERCENTILE SCORES IN THE 1980 YOUTH POPULATION

TABLE 2

CUMULATIVE FREQUENCY DISTRIBUTION OF NEW AFQT FOR MALES AND FEMALES IN THE 1980 YOUTH POPULATION

Form 8A raw score	Male cumulative proportion	Female cumulative proportion
1	.000912	.001197
2	.000994	.001197
3	.001066	.001197
4	.001066	.001275
5	.001066	.001275
6	.001138	.001330
7	.001324	.001505
8	.001324	.001895
9	.001324	.001984
10	.001324	.001984
11	.001592	.002191
12	.002021	.002191
13	.002021	.002191
14	.002527	.002945
15	.002860	.003168
16	.003397	.003499
17	.004679	.004253
18	.006010	.006218
19	.007989	.007724
20	.010464	.009426
21	.013179	.010502
22	.017657	.013321
23	.021830	.017134
24	.027382	.019434
25	.032610	.024950
26	.037830	.029428
27	.043063	.034942
28	.049261	.040572
29	.055985	.045087
30	.062811	.050469
31	.070215	.056865
32	.077821	.065223
33	.084053	.070845
34	.091063	.078265
35	.099405	.086220
36	.105281	.092384
37	.112398	.102374
38	.119724	.110448
39	.129444	.118019
40	.136916	.126737

TABLE 2 (Cont.)

Form 8A raw score	Male cumulative proportion	Female cumulative proportion
41	.144365	.135461
42	.151402	.146530
43	.161666	.155163
44	.171509	.162788
45	.178653	.172353
46	.185931	.183509
47	.197248	.194174
48	.209925	.206575
49	.219550	.217802
50	.230185	.228330
51	.237384	.238426
52	.251365	.251036
53	.261878	.262549
54	.270710	.273567
55	.283215	.286025
56	.293871	.306098
57	.302959	.318925
58	.312154	.333310
59	.323624	.349783
60	.333912	.363285
61	.344002	.378751
62	.353806	.394015
63	.369038	.411836
64	.381308	.428941
65	.398436	.442396
66	.411310	.456042
67	.422217	.470192
68	.437947	.484795
69	.450869	.504941
70	.466114	.519041
71	.477053	.537164
72	.489592	.551647
73	.503546	.564141
74	.513243	.583272
75	.531311	.598598
76	.545463	.609850
77	.564362	.627586
78	.580852	.647783
79	.597259	.666452
80	.610839	.682530

TABLE 2 (Cont.)

Form 8A raw score	Male cumulative proportion	Female cumulative proportion
81	.628044	.698759
82	.643072	.716025
83	.660141	.728099
84	.675198	.741873
85	.690427	.757905
86	.706530	.769831
87	.722925	.784029
88	.735754	.801873
89	.750161	.818928
90	.764861	.830618
91	.776356	.845805
92	.790436	.856685
93	.809579	.872813
94	.825293	.887376
95	.839800	.903869
96	.860762	.919470
97	.877579	.931117
98	.894797	.941409
99	.917095	.950199
100	.934172	.966303
101	.952447	.976218
102	.970529	.985382
103	.987790	.992052
104	.996889	.997744
105	1.000000	1.000000

Equating the New AFQT on ASVAB 11/12/13 to 8A

On 1 October 1984, forms 11, 12, and 13 of the ASVAB were introduced. An IOT&E was conducted in October and November 1984 to evaluate the accuracy of the score scale for ASVAB 11/12/13. Form 8A, labeled 13C in the IOT&E, was also administered, and it serves as the reference for evaluating the scaling of forms 11, 12, and 13. Forms 11, 12, and 13 were equated to form 8A using the linear and equipercentile techniques.

In linear equating, standard scores, or Z scores, on the forms to be equated are set equal to each other. Z scores were computed on forms 11/12B/13, 12A, and 8A for the 1984 IOT&E group and were used in the linear equating. The means, standard deviations, and formulas used to compute the 8A raw scores equivalent to the 11/12B/13 and 12A raw scores are shown in table 3.

The 8A raw scores equivalent to the 11/12B/13 and 12A scores were computed to two decimal places. The two-decimal 8A raw scores were converted to percentile scores in the 1980 Youth Population. Linear interpolation was used to find the cumulative proportion of the 1980 Youth Population that would have obtained each two-decimal 8A raw score. The two-decimal 8A raw scores that correspond to the 11/12B/13 and 12A raw scores and the cumulative proportions in the 1980 Youth Population are shown in table 4. No smoothing of the integers was performed. The integers are percentile scores in the 1980 Youth Population that correspond to the 11/12B/13 and 12A new AFQT raw scores.

In addition to linear equating, forms 11/12B/13 and 12A were also equated to 8A in the 1984 IOT&E group using the equipercentile equating technique. Whereas linear equating sets standard scores equal to each other, equipercentile equating sets raw scores that correspond to the same cumulative proportion equal to each other. Linear interpolation was used to find the two-decimal 8A raw score that is equivalent to each raw score on forms 11/12B/13 and 12A.

The cumulative proportions for forms 11/12B/13, 12A, and 8A are shown in appendix B. The two-decimal 8A raw scores that had the same cumulative proportion as the 11/12B/13 and 12A raw scores were computed. The 11/12B/13 and 12A raw scores and the corresponding 8A two-decimal raw scores are also shown in appendix B.

Conversion of the new AFQT raw scores on forms 11/12B/13 and 12A to percentile scores in the 1980 Youth Population is shown in table 5; the linear and equipercentile equating are both shown. The two sets of conversions are virtually

TABLE 3

COMPUTATIONS USED IN THE LINEAR EQUATING OF THE NEW AFQT FOR THE 1984 IOT&E GROUP

Panel A: Statistics used in linear equating

ASVAB form number	Mean($\overline{X}$)	Standard deviation(SD)
13C	68.893	17.655
11/12B/13	68.447	19.377
12A	67.296	19.601

Panel B: Equations used in linear equating

$$Raw\ score_{8A(13C)} = \frac{SD13C}{SD11}(Raw\ score_{11} - \overline{X}_{11}) + \overline{X}_{13C}$$

$$Raw\ score_{8A(13C)} = \frac{SD13C}{SD12A}(Raw\ score_{12A} - \overline{X}_{12A}) + \overline{X}_{13C}$$

TABLE 4

LINEAR EQUATING OF THE NEW AFQT FOR FORMS 11/12B/13 AND 12A

Form 11/12B/13 raw score	Form 8A equivalent: Raw score[a]	Form 8A equivalent: Cumulative proportion[b]	Form 8A equivalent: Percentile score
1	7.44	.001497	0
2	8.35	.001620	0
3	9.26	.001649	0
4	10.17	.001689	0
5	11.08	.001904	0
6	12.00	.002105	0
7	12.91	.002105	0
8	13.82	.002620	0
9	14.73	.002937	0
10	15.64	.003290	0
11	16.55	.004009	0
12	17.46	.005225	1
13	18.37	.006758	1
14	19.28	.008445	1
15	20.20	.010334	1
16	21.11	.012263	1
17	22.02	.015601	2
18	22.93	.019237	2
19	23.84	.022835	2
20	24.75	.027494	3
21	25.66	.032040	3
22	26.57	.036752	4
23	27.48	.041903	4
24	28.40	.047234	5
25	29.31	.052512	5
26	30.22	.058251	6
27	31.13	.064675	6
28	32.04	.071852	7
29	32.95	.077249	8
30	33.86	.083748	8
31	34.77	.091035	9
32	35.68	.097002	10
33	36.60	.104047	10
34	37.51	.111384	11
35	38.42	.118792	12
36	39.33	.126484	13
37	40.24	.133839	13
38	41.15	.141332	14
39	42.06	.149570	15
40	42.97	.158178	16
41	43.89	.166250	17
42	44.80	.173883	17
43	45.71	.182073	18
44	46.62	.191555	19
45	47.53	.202380	20

TABLE 4 (Cont.)

Form 11/12B/13 raw score	Form 8A equivalent		
	Raw score	Cumulative proportion	Percentile score
46	48.44	.212857	21
47	49.35	.222393	22
48	50.26	.231514	23
49	51.17	.240159	24
50	52.09	.252194	25
51	53.00	.262209	26
52	53.91	.271225	27
53	54.82	.282352	28
54	55.73	.295765	30
55	56.64	.306890	31
56	57.55	.317289	32
57	58.46	.328987	33
58	59.37	.340904	34
59	60.29	.352077	35
60	61.20	.363620	36
61	62.11	.375431	38
62	63.02	.390416	39
63	63.93	.403748	40
64	64.84	.417642	42
65	65.75	.430034	43
66	66.66	.441600	44
67	67.57	.454502	45
68	68.49	.469103	47
69	69.40	.483380	48
70	70.31	.496677	50
71	71.22	.509636	51
72	72.13	.521884	52
73	73.04	.533972	53
74	73.95	.547026	55
75	74.86	.562120	56
76	75.77	.574257	57
77	76.69	.589828	59
78	77.60	.606499	61
79	78.51	.622762	62
80	79.42	.637568	64
81	80.33	.651677	65
82	81.24	.666753	67
83	82.15	.681203	68
84	83.06	.694486	69
85	83.97	.707612	71
86	84.89	.721951	72
87	85.80	.734906	73
88	86.71	.748587	75
89	87.62	.762514	76
90	88.53	.776655	78

TABLE 4 (Cont.)

Form 11/12B/13 raw score	Form 8A equivalent		
	Raw score	Cumulative proportion	Percentile score
91	89.44	.789854	79
92	90.35	.801916	80
93	91.26	.813821	81
94	92.18	.826251	83
95	93.09	.842094	84
96	94.00	.855878	86
97	94.91	.869970	87
98	95.82	.886387	89
99	96.73	.900101	90
100	97.64	.912790	91
101	98.55	.926364	93
102	99.46	.941039	94
103	100.38	.955381	96
104	101.29	.968127	97
105	102.20	.980255	98

TABLE 4 (Cont.)

Form 12A raw score	Form 8A equivalent		
	Raw score	Cumulative proportion	Percentile score
1	9.18	.001649	0
2	10.08	.001668	0
3	10.98	.001882	0
4	11.88	.002079	0
5	12.78	.002105	0
6	13.68	.002532	0
7	14.58	.002895	0
8	15.48	.003221	0
9	16.38	.003835	0
10	17.29	.004945	0
11	18.19	.006444	1
12	19.09	.008047	1
13	19.99	.009932	1
14	20.89	.011650	1
15	21.79	.014752	1
16	22.69	.018278	2
17	23.59	.021848	2
18	24.49	.026098	3
19	25.39	.030729	3
20	26.29	.035249	4
21	27.19	.040186	4
22	28.09	.045487	5
23	28.99	.050560	5
24	29.90	.056120	6
25	30.80	.062257	6
26	31.70	.069222	7
27	32.60	.075174	8
28	33.50	.081152	8
29	34.40	.088019	9
30	35.30	.094715	9
31	36.20	.100634	10
32	37.10	.108229	11
33	38.00	.115154	12
34	38.90	.122950	12
35	39.80	.130284	13
36	40.70	.137555	14
37	41.60	.145392	15
38	42.51	.153827	15
39	43.41	.162050	16
40	44.31	.169797	17
41	45.21	.177479	18
42	46.11	.185947	19
43	47.01	.195858	20
44	47.91	.207146	21
45	48.81	.216710	22

TABLE 4 (Cont.)

Form 12A raw score	Form 8A equivalent		
	Raw score	Cumulative proportion	Percentile score
46	49.71	.226202	23
47	50.61	.234533	23
48	51.51	.244683	24
49	52.41	.255715	26
50	53.31	.265280	27
51	54.21	.274738	27
52	55.12	.286435	29
53	56.02	.300114	30
54	56.92	.309951	31
55	57.82	.320462	32
56	58.72	.332609	33
57	59.62	.343872	34
58	60.52	.355007	36
59	61.42	.366368	37
60	62.32	.378898	38
61	63.22	.393346	39
62	64.12	.406612	41
63	65.02	.420358	42
64	65.92	.432287	43
65	66.82	.443601	44
66	67.73	.456930	46
67	68.63	.471410	47
68	69.53	.485289	49
69	70.43	.498415	50
70	71.33	.511121	51
71	72.23	.523208	52
72	73.13	.535263	54
73	74.03	.548245	55
74	74.93	.563290	56
75	75.83	.575020	58
76	76.73	.590561	59
77	77.63	.607049	61
78	78.53	.623112	62
79	79.44	.637864	64
80	80.34	.651844	65
81	81.24	.666753	67
82	82.14	.681057	68
83	83.04	.694198	69
84	83.94	.707180	71
85	84.84	.721170	72
86	85.74	.734063	73
87	86.64	.747515	75
88	87.54	.761290	76
89	88.44	.775241	78
90	89.34	.788533	79

TABLE 4 (Cont.)

Form 12A raw score	Form 8A equivalent		
	Raw score	Cumulative proportion	Percentile score
91	90.24	.800451	80
92	91.14	.812320	81
93	92.05	.823956	82
94	92.95	.839848	84
95	93.85	.853606	85
96	94.75	.867493	87
97	95.65	.883273	88
98	96.55	.897533	90
99	97.45	.910167	91
100	98.35	.923235	92
101	99.25	.937553	94
102	100.15	.952125	95
103	101.05	.964841	96
104	101.95	.977162	98
105	102.85	.988083	99

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a. Equivalent 8A raw score computed through linear equating in the 1984 IOT&E group.
b. Cumulative proportion of the 1980 Youth Population that would have obtained the 2-decimal form 8A raw score; computed through linear interpolation.

TABLE 5

CONVERSION OF NEW AFQT RAW SCORES TO PERCENTILE SCORES
FOR FORMS 11/12B/13 AND 12A

Form 11/12B/13			Form 12A		
	Percentile			Percentile	
Raw score	Linear	Equipercentile	Raw score	Linear	Equipercentile
1	0	0	1	0	0
2	0	0	2	0	0
3	0	0	3	0	0
4	0	0	4	0	0
5	0	0	5	0	0
6	0	0	6	0	0
7	0	0	7	0	0
8	0	0	8	0	0
9	0	0	9	0	0
10	0	0	10	0	0
11	0	0	11	1	0
12	1	0	12	1	0
13	1	0	13	1	0
14	1	0	14	1	1
15	1	1	15	1	1
16	1	1	16	2	1
17	2	1	17	2	1
18	2	1	18	3	1
19	2	2	19	3	2
20	3	2	20	4	2
21	3	2	21	4	3
22	4	3	22	5	3
23	4	3	23	5	4
24	5	4	24	6	4
25	5	5	25	6	5
26	6	5	26	7	5
27	6	6	27	8	6
28	7	6	28	8	7
29	8	7	29	9	7
30	8	8	30	9	8
31	9	9	31	10	9
32	10	9	32	11	10
33	10	10	33	12	11
34	11	11	34	12	12
35	12	12	35	13	13
36	13	12	36	14	13
37	13	13	37	15	14
38	14	14	38	15	15
39	15	15	39	16	16
40	16	16	40	17	17

TABLE 5 (Cont.)

Form 11/12B/13			Form 12A		
	Percentile			Percentile	
Raw score	Linear	Equipercentile	Raw score	Linear	Equipercentile
41	17	17	41	18	18
42	17	18	42	19	19
43	18	19	43	20	20
44	19	20	44	21	21
45	20	21	45	22	22
46	21	22	46	23	23
47	22	23	47	23	24
48	23	24	48	24	25
49	24	25	49	26	26
50	25	26	50	27	27
51	26	27	51	27	28
52	27	28	52	29	29
53	28	29	53	30	31
54	30	30	54	31	31
55	31	31	55	32	33
56	32	32	56	33	34
57	33	33	57	34	35
58	34	34	58	36	36
59	35	36	59	37	37
60	36	37	60	38	39
61	38	38	61	39	40
62	39	39	62	41	41
63	40	41	63	42	43
64	42	42	64	43	44
65	43	43	65	44	45
66	44	44	66	46	46
67	45	46	67	47	47
68	47	47	68	49	49
69	48	48	69	50	50
70	50	50	70	51	51
71	51	51	71	52	52
72	52	52	72	54	53
73	53	53	73	55	55
74	55	54	74	56	56
75	56	56	75	58	57
76	57	57	76	59	59
77	59	58	77	61	60
78	61	60	78	62	62
79	62	62	79	64	63
80	64	63	80	65	65
81	65	64	81	67	66
82	67	66	82	68	67
83	68	67	83	69	68
84	69	69	84	71	70
85	71	70	85	72	71

TABLE 5 (Cont.)

Form 11/12B/13			Form 12A		
	Percentile			Percentile	
Raw score	Linear	Equipercentile	Raw score	Linear	Equipercentile
86	72	71	86	73	72
87	73	73	87	75	73
88	75	74	88	76	75
89	76	75	89	78	76
90	78	77	90	79	78
91	79	79	91	80	79
92	80	80	92	81	80
93	81	81	93	82	82
94	83	82	94	84	83
95	84	84	95	85	85
96	86	86	96	87	86
97	87	87	97	88	88
98	89	89	98	90	90
99	90	91	99	91	92
100	91	92	100	92	93
101	93	94	101	93	95
102	94	96	102	95	97
103	96	98	103	96	98
104	97	99	104	98	99
105	98	99	105	99	99

identical, which is expected because the content of the forms is parallel. The conversions based on the linear equating are plotted in figure 2 for forms 11/12B/13 and figure 3 for form 12A. These values are identical to the linear equating shown in table 4 except for one change to form 12A. For administrative reasons, the raw score of 101 on form 12A is converted to a percentile score of 93, vice 94, because the percentile score of 93 is the bottom of AFQT Category I. By reducing the percentile score from 94 to 93, the number of examinees classified into category I would not be changed.

Because the results of linear equating tend to be more stable, they are generally preferred over those from the equipercentile method. The current practice for the ASVAB is to use linear equating, and these results do not show any reason to change.

The percentile scores for the new AFQT in the 1980 Youth Population (table 1, reported earlier) have been based on the sum of subtest raw scores. Instead of summing and converting raw scores, an alternative is to convert the subtest raw scores to standard scores, and then convert the sums of subtest standard scores to percentile scores. Advantages of summing subtest standard scores are that the subtests in the AFQT are equally weighted and that more values of the sum of standard scores than of the sum of raw scores occur, which means in turn that there are fewer gaps in the percentile score scale. The conversion of sums of subtest standard scores to percentile scores is being evaluated by the Joint Services Selection and Classification Working Group, which is responsible for the technical adequacy of the ASVAB, including the AFQT.

The new AFQT in which MK replaces NO is an improvement over the one it replaces. MK does not suffer from the inherent defects that render NO inappropriate for use in a test as visible as the AFQT [3]. MK is a stable measure of ability that cannot be changed easily through practice. In addition, it is a good measure of general trainability [4]. The new AFQT corrects the problems arising from the NO subtest.

RECOMMENDATIONS

- The conversion of raw scores to percentile scores shown in table 1 should be adopted for operational use.

- The conversion tables for ASVAB 11/12/13 based on linear equating (table 5) should be adopted for operational use.

- Subsequent forms of ASVAB should be scaled to the reference population using the six-digit cumulative frequency shown in table 1.

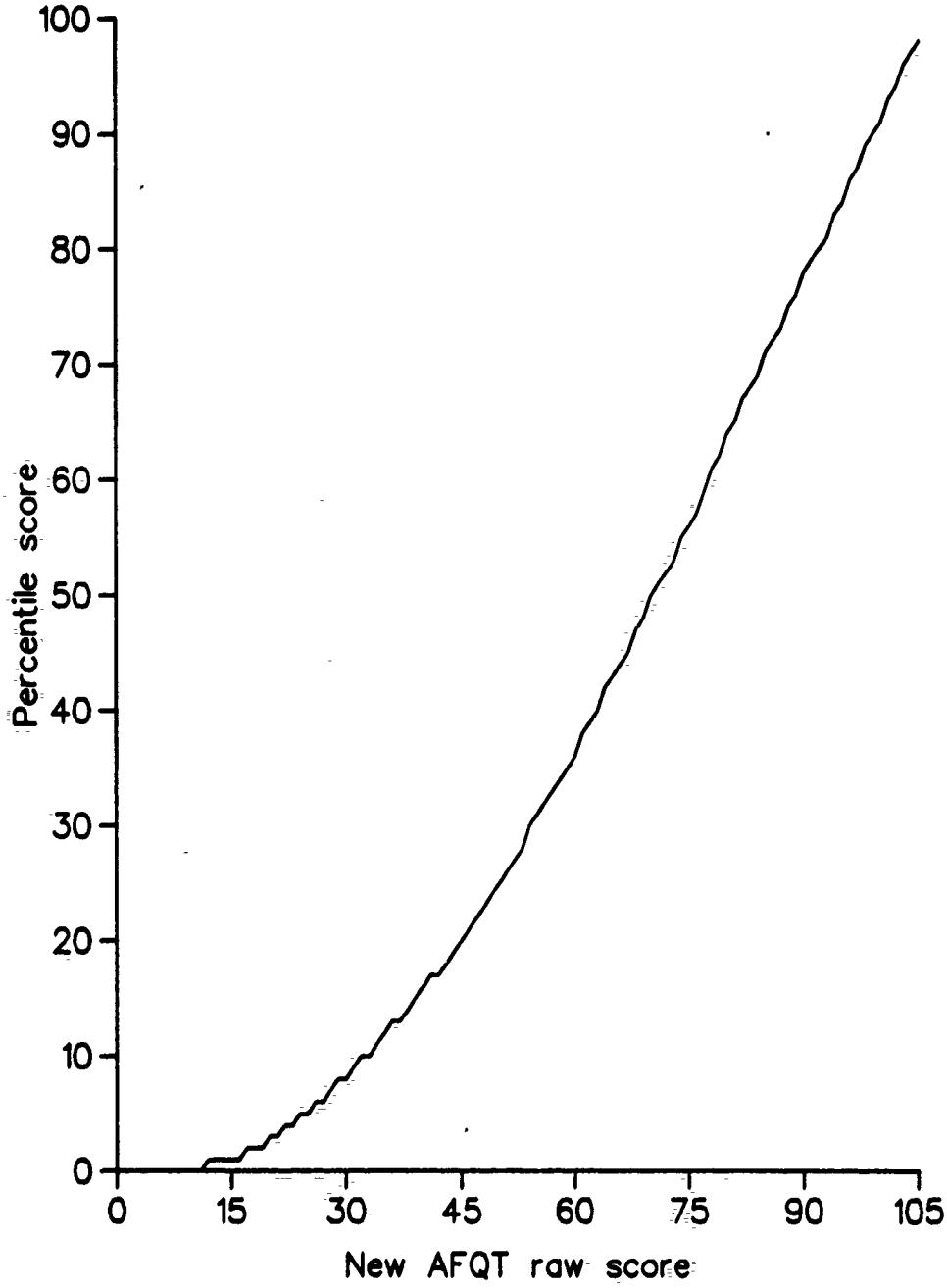

FIG. 2: CONVERSION OF NEW AFQT RAW SCORES TO PERCENTILE SCORES FOR ASVAB FORMS 11/12B/13

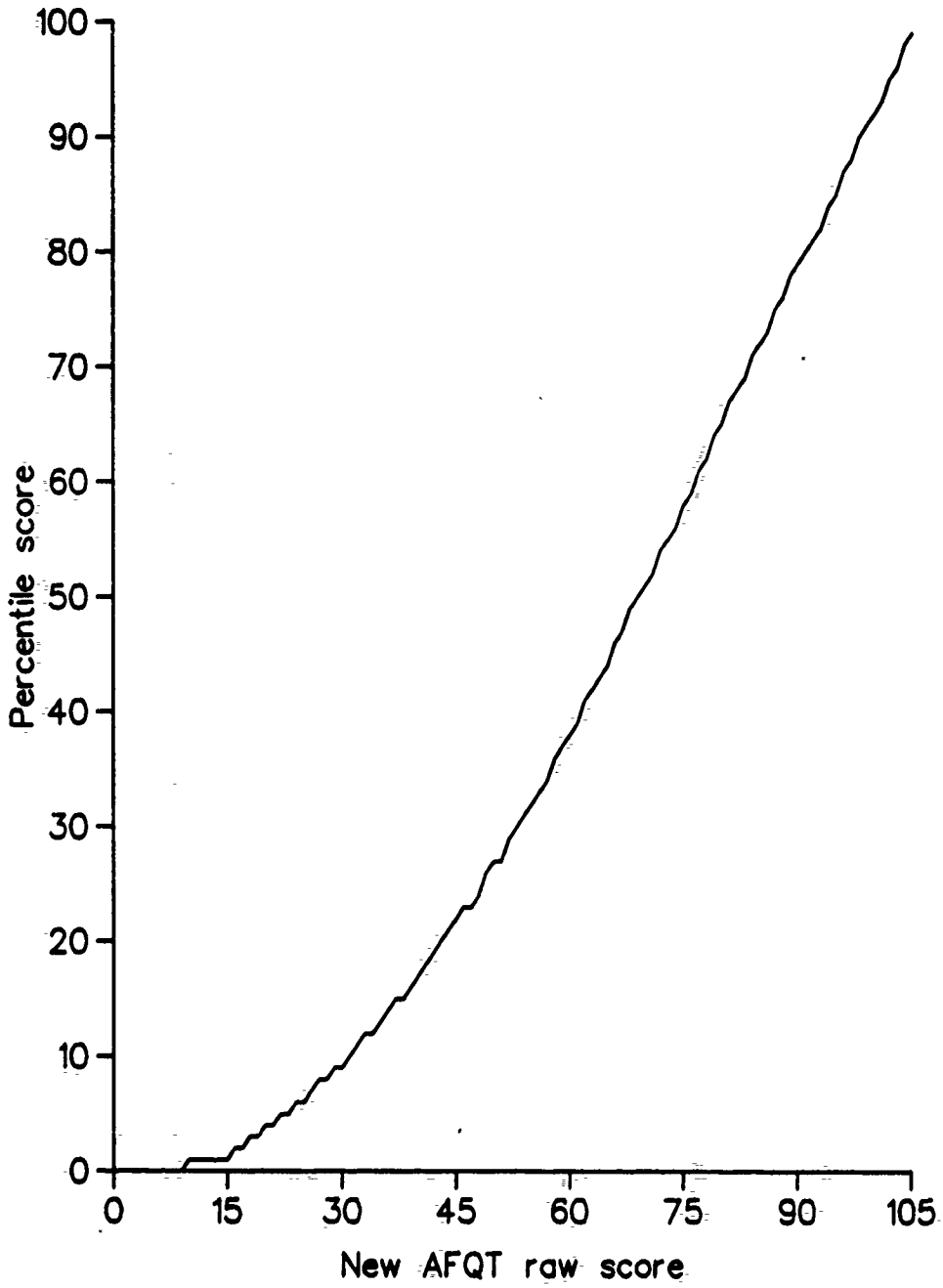

FIG. 3: CONVERSION OF NEW AFQT RAW SCORES TO PERCENTILE SCORES FOR ASVAB FORM 12A

REFERENCES

[1] Assistant Secretary of Defense (Force Management and Personnel, Accession Policy), *A Review of the Development and Implementation of the Armed Services Vocational Aptitude Battery, Forms 11, 12, and 13*, prepared by a Subcommittee of the Joint Service Selection and Classification Working Group, Unclassified, May 1986

[2] Air Force Human Resources Laboratory, *The 1980 Youth Population: An Investigation of Speeded Subtests*, by James A. Earles, Toni Giulliano Wegner, Malcolm J. Ree, and Lonnie D. Valentine, Jr., Unclassified, Aug 1983

[3] CNA Research Memorandum 86-228, *Evaluating the Appropriateness of the Numerical Operations and Math Knowledge Subtests in the AFQT*, by Milton H. Maier and Catherine M. Hiatt, Unclassified, Nov 1986

[4] CNA Report 102, *Validity of the Armed Services Vocational Aptitude Battery Forms 8, 9, and 10 With Applications to Forms 11, 11, 13, and 14*, by Milton H. Maier and Ann R. Truss, Unclassified, Feb 1985

APPENDIX A

EQUATING EACH FORM OF ASVAB 11/12/13 TO FORM 8A

APPENDIX A

EQUATING EACH FORM OF ASVAB 11/12/13 TO FORM 8A

With the introduction of automated scoring equipment at Military Enlistment Processing Stations (MEPS), the use of a separate conversion table for each form of the ASVAB is feasible. When scoring the ASVAB was accomplished by hand, including computation of the AFQT and aptitude composite scores, clerical errors would have been introduced from the use of six conversion tables, one for each form of the AFQT. Because extensive lead time is required to reprogram the scoring machines to accommodate six conversion tables instead of the existing two tables, the new AFQT initially will conform to the current structure and have two tables—one for forms 11A/11B/12B/13A/13B and one for form 12A. In subsequent years, separate conversion tables may be used for each form.

The conversion of new AFQT raw scores to percentile scores for each form of ASVAB 11/12/13 is shown in table A-1. Each form was equated to 8A using data from the 1984 IOT&E. The linear equating technique was used to prepare the conversion tables. The means, standard deviations, and computing formula are shown in table A-2. The procedures are the same as used in the main text: the two-decimal 8A raw score equivalent to each new AFQT raw score was computed; the exact proportion of the 1980 Youth Population that attained each two-decimal 8A raw score was computed using linear interpolation; the proportions were rounded to integers, which are reported in table A-1.

The percentile scores in table A-1 show little variation from form to form. The main reason is that the subtests were designed to be parallel by having the same means and standard deviations. The differences in percentile scores corresponding to the same raw score will be evaluated by the Joint Service Selection and Classification Working Group when preparing a recommendation about using separate conversion tables.

TABLE A-1

CONVERSION OF NEW AFQT RAW SCORES TO PERCENTILE SCORES FOR EACH ASVAB FORM

Raw score	Percentile score					
	11A	11B	12A	12B	13A	13B
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	1	0	1	1	0	0
12	1	1	1	1	0	0
13	1	1	1	1	0	0
14	1	1	1	1	1	1
15	1	1	1	1	1	1
16	2	1	2	1	1	1
17	2	2	2	2	1	1
18	2	2	3	2	1	1
19	3	2	3	3	2	2
20	3	3	4	3	2	2
21	4	3	4	4	3	3
22	4	4	5	4	3	3
23	5	4	5	5	3	4
24	5	5	6	5	4	4
25	6	6	6	6	5	5
26	6	6	7	6	5	5
27	7	7	8	7	6	6
28	8	7	8	7	6	6
29	8	8	9	8	7	7
30	9	9	9	9	8	8
31	10	9	10	9	8	8
32	10	10	11	10	9	9
33	11	11	12	11	10	10
34	12	12	12	11	10	10
35	12	12	13	12	11	11
36	13	13	14	13	12	12
37	14	14	15	14	13	13
38	15	15	15	14	13	13
39	16	15	16	15	14	14
40	16	16	17	16	15	15

TABLE A-1 (Cont.)

Raw score	Percentile score					
	11A	11B	12A	12B	13A	13B
41	17	17	18	17	16	16
42	18	18	19	18	17	17
43	19	19	20	18	17	17
44	20	20	21	19	18	18
45	21	21	22	21	19	19
46	22	22	23	21	20	20
47	23	23	23	22	21	21
48		24	24	23	22	22
49	25		26	24	23	23
50	26	26	27	25	24	24
51	27	27	27	26	25	25
52	28	28	29	27	26	26
53	29	29	30	28	27	27
54	30	30	31	30	29	29
55	31	31	32	31	30	30
56	32	33	33	32	31	31
57	33	34	34	33	32	32
58	34	35	36	34	33	33
59	36	36	37	35	35	34
60	37	37	38	36	36	36
61	38	39	39	37	37	37
62	39	40	41	39	38	38
63	41	41	42	40	40	40
64	42	43	43	42	41	41
65	43	44	44	43	42	42
66	44	45	46	44	44	44
67	46	47	47	45	45	45
68	47	48	49	47	46	46
69	48	49	50	48	48	48
70	50	51	51	49	49	49
71	51	52	52	51	51	50
72	52	53	54	52	52	52
73	53	55	55	53	53	53
74	55	56	56	54	54	54
75	56	57	58	56	56	56
76	57	59	59	57	57	57
77	59	60	61	58	59	58
78	61	62	62	60	60	60
79	62	64	64	62	62	62
80	64	65	65	63	64	63
81	65	67	67	64	65	65
82	66	68	68	66	67	66
83	68	69	69	67	68	68
84	69	71	71	69	69	69
85	70	72	72	70	71	71

TABLE A-1 (Cont.)

Raw score	Percentile score					
	11A	11B	12A	12B	13A	13B
86	72	73	73	71	72	72
87	73	75	75	73	74	73
88	74	76	76	74	75	75
89	76	78	78	75	76	76
90	77	79	79	77	78	78
91	79	80	80	78	79	79
92	80	81	81	79	80	80
93	81	83	82	81	82	81
94	82	84	84	82	83	83
95	84	86	85	83	85	84
96	85	87	87	84	86	86
97	86	89	88	86	88	87
98	88	90	90	87	89	89
99	89	91	91	89	90	90
100	91	93	92	90	92	91
101	92	94	94	91	93	93
102	93	96	95	93	95	94
103	95	97	96	94	96	96
104	96	98	98	96	97	97
105	97	99	99	97	99	98

TABLE A-2

COMPUTATIONS USED IN THE LINEAR EQUATING OF THE NEW AFQT FOR THE 1984 IOT&E GROUP BY FORM NUMBER

Panel A: Statistics used in linear equating

ASVAB form number	Mean($\overline{X}$)	Standard deviation(SD)
11A	68.341	19.752
11B	67.618	19.226
12A	67.296	19.601
12B	68.688	19.771
13A	68.793	18.933
13B	68.925	19.048
13C	68.893	17.655

Panel B: Equation used in linear equating

$$Raw\ score_{8A(13C)} = \frac{SD13C}{SD11}(Raw\ score_{11} - \overline{X}_{11}) + \overline{X}_{13C}$$

APPENDIX B

EQUIPERCENTILE EQUATING OF ASVAB 11/12/13 TO FORM 8A

APPENDIX B

EQUIPERCENTILE EQUATING OF ASVAB 11/12/13 TO FORM 8A

The equipercentile equating of forms 11/12B/13 and 12A to form 8A is described in this appendix. The procedures were described in the main text. Table B-1 shows the cumulative proportions in the 1984 IOT&E for forms 8A (13C), 11/12B/13, and 12A. These values are the input to equipercentile equating. Table B-2 shows the results of the equipercentile equating of forms 11/12B/13 and 12A to form 8A. As presented in the main text (table 5), the results of the equipercentile and linear equating are virtually identical throughout the useful score range (percentile scores 5 through 95).

Also shown in table B-2 are the cumulative proportions in the 1980 Youth Population that would have obtained each raw score on forms 11/12B/13 and 12A. The cumulative proportions were computed using linear interpolation. In the last column of table B-2, the cumulative proportions were rounded to integers, which are percentile scores.

TABLE B-1

CUMULATIVE PROPORTIONS OF THE NEW AFQT SCORES
FOR THE 1984 IOT&E GROUP

Raw score	Form 13C(8A)	Form 11/12B/13	Form 12A
7	0.000000	0.000012	0.000000
8	0.000000	0.000012	0.000000
9	0.000000	0.000012	0.000000
10	0.000000	0.000024	0.000000
11	0.000000	0.000024	0.000000
12	0.000000	0.000083	0.000109
13	0.000000	0.000094	0.000109
14	0.000000	0.000118	0.000218
15	0.000000	0.000212	0.000218
16	0.000066	0.000330	0.000381
17	0.000199	0.000566	0.000544
18	0.000199	0.000837	0.000979
19	0.000266	0.001308	0.001415
20	0.000266	0.001839	0.002068
21	0.000797	0.002581	0.003211
22	0.001195	0.003607	0.004027
23	0.001726	0.004915	0.005496
24	0.002456	0.006271	0.007128
25	0.003717	0.008227	0.009087
26	0.004912	0.010373	0.011427
27	0.006505	0.012942	0.014094
28	0.008165	0.015677	0.017413
29	0.010820	0.018918	0.020406
30	0.013077	0.022690	0.024977
31	0.015798	0.026403	0.028732
32	0.018852	0.030211	0.034173
33	0.021905	0.034690	0.040703
34	0.025821	0.039534	0.046580
35	0.030402	0.045333	0.052348
36	0.034982	0.051109	0.059259
37	0.039960	0.057769	0.065626
38	0.045470	0.064818	0.073733
39	0.051245	0.072420	0.082277
40	0.058745	0.080294	0.092779
41	0.066512	0.089724	0.103009
42	0.074477	0.100061	0.114001
43	0.081381	0.110222	0.126245
44	0.090607	0.121113	0.138053
45	0.099502	0.132394	0.151548
46	0.108530	0.143957	0.165098
47	0.120080	0.156003	0.177396
48	0.133687	0.169252	0.189911
49	0.146499	0.183279	0.205692
50	0.158513	0.197541	0.219296
51	0.172917	0.212051	0.236328
52	0.189844	0.227528	0.251673
53	0.206173	0.243558	0.268270
54	0.223498	0.258587	0.284105
55	0.240624	0.275254	0.300103

TABLE B-1 (Cont.)

Raw score	Form 13C(8A)	Form 11/12B/13	Form 12A
56	0.257949	0.292841	0.317299
57	0.277796	0.309236	0.334059
58	0.296183	0.326717	0.351690
59	0.315831	0.344009	0.370082
60	0.332692	0.361925	0.386788
61	0.351610	0.378840	0.403439
62	0.370926	0.396426	0.421342
63	0.389910	0.413506	0.438973
64	0.411948	0.431611	0.457420
65	0.430999	0.448537	0.474180
66	0.452373	0.466607	0.489253
67	0.471955	0.484394	0.505686
68	0.490939	0.500719	0.522501
69	0.510787	0.518306	0.540785
70	0.530833	0.535362	0.557817
71	0.550548	0.552512	0.574033
72	0.569532	0.569061	0.590466
73	0.588516	0.585504	0.608750
74	0.608895	0.602442	0.626598
75	0.628543	0.619310	0.641726
76	0.647196	0.635305	0.655874
77	0.664720	0.650369	0.670131
78	0.680584	0.666954	0.686293
79	0.698108	0.681758	0.700713
80	0.716296	0.696987	0.715024
81	0.733687	0.712405	0.728084
82	0.750548	0.727681	0.741797
83	0.766280	0.742839	0.753714
84	0.781746	0.757019	0.768025
85	0.797810	0.770740	0.779453
86	0.813608	0.785745	0.793764
87	0.828344	0.799830	0.808728
88	0.840624	0.814022	0.821951
89	0.853900	0.827990	0.836208
90	0.867508	0.841486	0.849812
91	0.881912	0.855478	0.863362
92	0.895387	0.868573	0.875497
93	0.907069	0.881586	0.888611
94	0.919283	0.894399	0.901725
95	0.931630	0.907565	0.915438
96	0.942781	0.919930	0.925940
97	0.952207	0.931411	0.938945
98	0.962562	0.943351	0.949883
99	0.970661	0.954018	0.961800
100	0.978493	0.964745	0.970235
101	0.986791	0.975341	0.979866
102	0.992101	0.984111	0.987865
103	0.996880	0.991785	0.994014
104	0.999403	0.997112	0.998422
105	1.000000	1.000000	1.000000

TABLE B-2

EQUIPERCENTILE EQUATING OF NEW AFQT FOR
FORMS 11/12B/13 AND 12A

Form 11/12B/13 raw score	Form 8A equivalent		
	Raw score	Cumulative proportion	Percentile score
1-12	16.12	.003570	0
13	16.21	.003662	0
14	16.39	.003846	0
15	18.20	.006461	1
16	20.12	.010182	1
17	20.57	.011040	1
18	21.10	.012226	1
19	22.21	.016360	2
20	23.15	.020110	2
21	24.10	.024004	2
22	24.91	.028353	3
23	26.00	.033691	3
24	26.85	.038256	4
25	28.02	.045093	5
26	28.83	.049658	5
27	29.94	.056364	6
28	30.96	.063362	6
29	32.02	.071734	7
30	33.20	.078988	8
31	34.13	.085818	9
32	34.96	.092584	9
33	35.94	.098566	10
34	36.91	.106692	11
35	37.98	.115000	12
36	38.98	.123643	12
37	39.67	.130850	13
38	40.78	.138201	14
39	41.74	.146656	15
40	42.84	.156948	16
41	43.90	.166338	17
42	45.06	.176101	18
43	46.15	.186387	19
44	47.08	.196736	20
45	47.90	.207021	21
46	48.80	.216606	22
47	49.79	.227049	23
48	50.75	.235741	24
49	51.61	.246014	25
50	52.47	.256376	26
51	53.34	.265578	27
52	54.24	.275113	28
53	55.17	.287199	29
54	56.03	.300223	30
55	56.87	.309404	31

TABLE B-2 (Cont.)

Form 11/12B/13 raw score	Form 8A equivalent		
	Raw score	Cumulative proportion	Percentile score
56	57.82	.320462	32
57	58.66	.331773	33
58	59.65	.344228	34
59	60.60	.356026	36
60	61.53	.367743	37
61	62.42	.380548	38
62	63.30	.394518	39
63	64.08	.406000	41
64	65.03	.420491	42
65	65.82	.430961	43
66	66.73	.442476	44
67	67.66	.455868	46
68	68.49	.469103	47
69	69.38	.483087	48
70	70.23	.495519	50
71	71.10	.508017	51
72	71.98	.519894	52
73	72.84	.531281	53
74	73.68	.543153	54
75	74.53	.556603	56
76	75.36	.569040	57
77	76.18	.580482	58
78	77.14	.598073	60
79	78.07	.615052	62
80	78.94	.630296	63
81	79.79	.643048	64
82	80.65	.657029	66
83	81.54	.671592	67
84	82.41	.685002	69
85	83.29	.697804	70
86	84.25	.711951	71
87	85.13	.725496	73
88	86.03	.738174	74
89	86.98	.752722	75
90	88.06	.769271	77
91	89.12	.785625	79
92	90.07	.798188	80
93	90.98	.810304	81
94	91.93	.822198	82
95	93.04	.841337	84
96	94.05	.856652	86
97	94.98	.871054	87
98	96.06	.890541	89
99	97.17	.906301	91
100	98.27	.921984	92
101	99.60	.943362	94
102	100.68	.959627	96
103	101.94	.977025	98
104	103.09	.990557	99
105	103.09	.990557	99

TABLE B-2 (Cont.)

Form 12A raw score	Form 8A equivalent		
	Raw score	Cumulative proportion	Percentile score
1-12	16.32	.003774	0
13	16.32	.003774	0
14	18.28	.006601	1
15	18.28	.006601	1
16	20.22	.010373	1
17	20.52	.010945	1
18	21.46	.013544	1
19	22.41	.017159	2
20	23.47	.021374	2
21	24.60	.026688	3
22	25.26	.030098	3
23	26.37	.035678	4
24	27.38	.041311	4
25	28.35	.046953	5
26	29.27	.052267	5
27	30.37	.059287	6
28	31.53	.067866	7
29	32.51	.074640	7
30	33.78	.083171	8
31	34.64	.089975	9
32	35.82	.097844	10
33	37.13	.108460	11
34	38.19	.116800	12
35	39.15	.125029	13
36	40.07	.132466	13
37	40.89	.139090	14
38	41.91	.148190	15
39	43.10	.159337	16
40	44.24	.169214	17
41	45.39	.179133	18
42	46.47	.189906	19
43	47.45	.201377	20
44	48.34	.211816	21
45	49.42	.223133	22
46	50.46	.233239	23
47	51.26	.241357	24
48	52.00	.251203	25
49	52.97	.261879	26
50	53.76	.269739	27
51	54.75	.281479	28
52	55.64	.294388	29
53	56.52	.305579	31
54	57.34	.314821	31
55	58.20	.325364	33

TABLE B-2 (Cont.)

Form 12A raw score	Form 8A equivalent		
	Raw score	Cumulative proportion	Percentile score
56	59.09	.337579	34
57	60.07	.349275	35
58	61.00	.361121	36
59	61.96	.373115	37
60	62.84	.387482	39
61	63.61	.399060	40
62	64.49	.412280	41
63	65.37	.424997	42
64	66.26	.436598	44
65	67.12	.447673	45
66	67.91	.459661	46
67	68.74	.473223	47
68	69.58	.486023	49
69	70.50	.499428	50
70	71.38	.511796	51
71	72.24	.523340	52
72	73.10	.534833	53
73	73.99	.547600	55
74	74.90	.562788	56
75	75.71	.573493	57
76	76.50	.586346	59
77	77.34	.601737	60
78	78.33	.619608	62
79	79.14	.633421	63
80	79.93	.645121	65
81	80.68	.657530	66
82	81.48	.670624	67
83	82.20	.681934	68
84	83.11	.695208	70
85	83.85	.705881	71
86	84.75	.719764	72
87	85.69	.733361	73
88	86.57	.746443	75
89	87.64	.762820	76
90	88.69	.779169	78
91	89.70	.793291	79
92	90.55	.804579	80
93	91.50	.816822	82
94	92.54	.832608	83
95	93.69	.851182	85
96	94.54	.864240	86
97	95.66	.883456	88
98	96.75	.900387	90
99	97.93	.916794	92
100	98.95	.932621	93
101	100.17	.952408	95
102	101.20	.966895	97
103	102.40	.982663	98
104	103.61	.994416	99
105	103.61	.994416	99